FIXTURE AND LOCATOR DEVICE FOR SUPPORTING A ROTATABLE MEMBER

FIELD OF THE INVENTION

The present invention relates generally to a fixture and method for supporting a rotatable member such as a wheel or spindle during manufacture and, more particularly, a fixture that can support a boreless rotatable member such as a boreless compressor wheel.

BACKGROUND OF THE INVENTION

Boreless compressor wheels are characterized by a hub that extends in an axial direction with first and second opposite faces and a plurality of blades that extend radially on the first face. In operation, the wheel is configured to rotate about its axis so that the blades move, or are moved by, air passing proximate to the first face of the wheel. For example, the wheel can be mounted in a housing with a connection portion on the second face of the wheel engaged to a shaft so that as the shaft and the wheel are rotated, the blades push air through the housing. As the name suggests, a boreless compressor wheel does not have a bore that extends through the hub for mounting. Instead, the connection portion on the second face can extend from the face or can define an aperture that does not extend to the first face of the wheel.

During the manufacture of a boreless compressor wheel, the wheel must be sufficiently supported so that the faces and/or blades can be machined or otherwise formed to desired tolerances. Therefore, the compressor wheel is supported to resist the forces on the wheel associated with the machining or other forming operations.

For example, during a conventional manufacturing process, the boreless compressor wheel is supported in a chuck and turned, i.e., machined, in a lathe.

The chuck receives at least part of the blades and the first face of the wheel so that the wheel can be sufficiently supported while the lathe is used to partially form or finish the exposed faces and/or blades. The wheel is then removed from the chuck and secured in a second chuck that supports the wheel by other portions to expose the portions that were previously inaccessible for machining. Thus, those portions of the first face and blades that are obstructed by the first chuck can be formed while the wheel is secured in the second chuck. However, the use of successive machining operations increases the time required for forming or finishing the wheel. Further, the cost of the two chucks required for securing the wheel increases the cost of the wheels.

Thus, there exists a need for an improved fixture for supporting a boreless compressor wheel or other rotatable member. Preferably, the fixture should be capable of securing the member so that the member can be machined or otherwise formed to predetermined dimensions within predetermined tolerances. Further, the fixture should secure the member without obstructing access to portions of the member that are to be machined, for example, the blades of a boreless compressor wheel, so that the member can be machined without removing the member from the fixture.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

Figure 1 is section view illustrating a fixture for supporting a rotatable member during manufacture according to one embodiment of the present invention;

Figure 2 is an elevation view illustrating the locator device of the fixture of Figure 1;

Figure 3 is a side view illustrating the right side of the locator device of Figure 2;

Figure 4 is an elevation view illustrating the collet of the fixture of Figure 1;

Figure 4A is an enlarged view illustrating a portion of the collet of Figure 4, as indicated in Figure 4;

Figure 5 is a side view illustrating the right side of the collet of Figure 4; and

Figure 5A is an enlarged view illustrating a portion of the collet of Figure 4, as indicated in Figure 5.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

Referring now to the figures and, in particular, Figure 1, there is shown a fixture **10** for supporting a rotatable member **100** with a plurality of radial portions **110**. The rotatable member **100** can be a wheel, spindle, or other rotatable member that is supported by the fixture **10** during manufacture and subsequently installed in a rotary device such as a compressor, turbocharger, pump, blower, and

the like. In addition, the rotatable member **100** can be a boreless device, i.e., one without a bore extending therethrough for receiving a shaft or other mounting device for securing the member.

The rotatable member **100** illustrated in Figure 1 is a boreless compressor wheel. The member **100** has first and second curved faces **102**, **104** directed generally in opposite axial directions of the member **100**. The radial portions **110** of the member **100** are blades that extend axially and radially from the first face **102** of the member **100**. Part of the first face **102** is a surface of revolution and, in operation, defines the inner diameter of a generally annular flowpath through a compressor in which the wheel **100** is mounted. First and second connection portions are defined on the faces **102**, **104** for mounting the member **100** during operation. For example, the first face **102** can define a hexagonal head **106** and the second face **104** can define a threaded aperture **108** so that the member **100** can be installed in a compressor with the head **106** engaged by a corresponding socket and the aperture **108** engaging a threaded shaft. The member **100** can be rotated in the compressor so that the blades compress air passing through a housing of the compressor. Thus, for example, the compressor can be used to compress air in operation of a turbocharger.

The fixture **10** is used to support the member **100** during manufacture, for example, while the member **100** is formed to predetermined dimensions by machining. For instance, the member **100** may be cast to a near net shape, and may then be machined to the final desired dimensions. A locator device **20**, shown individually in Figures 2 and 3, corresponds to the rotatable member **100** so that the member **100** can be supported during machining without the use of a rod or shaft extending through the member **100**. In particular, the locator device **20** has a base **22** and a plurality of flanges **24**. The flanges **24** extend from the base **22** in the axial direction and are arranged circumferentially to define an aperture **25**. The aperture **25** is large enough to at least partially receive the member **100** in the axial direction. Further, the flanges **24** define slots **26**

therebetween for receiving the radial portions **110** of the member **100**. As shown in Figure 1, the first face **102** of the member **100** is received by the locator device **20** with the radial portions **110** extending radially through the slots **26**. Thus, the curved edge, or profile **112**, of the radial portions **110** can be formed to a desired contour, for example, by machining, while the member **100** is supported in the locator device **20**.

The configuration of the flanges **24** and, hence, the slots **26**, can correspond to the configuration of the radial portions **110** of the rotatable member **100**. For example, the flanges **24** can extend helically in the axial direction to receive correspondingly helical radial portions **110**. The flanges **24** can also flare radially outward to define a curved inner portion **27**. The curved inner portion **27** can define a curvature that is similar or different than the curvature of the first face **102** of the member **100**. According to one embodiment of the present invention, the flanges **24** flare about 90 degrees so that the curved inner portion **27** defines a surface **28** perpendicular to the axial direction and directed toward the first face of the member **100**. Thus, the surface **28** supports the member **100** axially. Further, each flange **24** can define a lip **30** that extends in the axial direction from the surface **28**. The lips **30** can collectively correspond to an outer circumference of the rotatable member **100** so that the lips **30** align and retain the member **100** radially in the fixture **10**, as best seen in Figure 1.

The base **22** of the locator device is connected by an adapter plate **40** to a spindle **50**, such as a spindle of a lathe, which is configured to rotate about an axis collinear with the axis of the rotatable member **100** so that the member **100** can be turned, or machined, to predetermined dimensions. The adapter plate **40** defines connection features for connecting to each of the spindle **50** and the locator device **20**. For example, bolts **42** can extend through bores **44** in the adapter plate **40** and into a front face **52** of the spindle **50** that is directed toward the rotatable member **100**, and additional bolts **46** can extend through the locator device **20** and into tapped apertures **48** of the adapter plate **40**.

The spindle **50** and the adapter plate **40** define a bore **54** through which a collet **60** extends. The collet **60**, which is illustrated individually in Figures 4, 4A, 5 and 5A, extends in the axial direction of the member and is configured to rotate with the spindle **50**. An end **62** of the collet **60** defines an aperture **64** for receiving the head **106** of the member **100**. In addition, radial slots **66** extend from the aperture **64** to an outer surface **68** of the collet **60** and axially from the end **62** of the collet **60** along a portion of the collet **60**. Axially extending ridges **70** are also provided on an inner surface **72** of the collet **60** for supporting the member **100**. Thus, the head **106** of the member **100** can be urged into the aperture **64**, slid along the ridges **70**, and supported therein.

The adapter plate **40** and/or the locator device **20** can be removed from the spindle **50** and replaced with substitute components that correspond to a particular rotatable member **100**. Thus, the spindle **50** and/or the collet **60** can be used with adapter plates and locator devices of different configurations for processing rotatable members **100** having different configurations in the fixture **10**.

Preferably, the fixture **10** secures the member **100** so that the member **100** can be formed using a tool **80** that exerts a force on the rotatable member **100**, e.g., in a direction transverse to the axial direction. For example, as shown in Figure 1, the tool **80** is supported on an arm **82**. A cutting edge **84** of the tool **80** is urged against the profile **112** of the radial portions **110** of the member **100** as the member **100** is rotated about its axis. The tool **80** successively contacts the radial portions **110** of the member **100**, thereby removing material from the radial portions **110** until the radial portions **110** are formed to predetermined dimensions. The arm **82** can be adjusted to move the tool **80** in the axial and radial directions. In particular, the arm **82** can be secured to a tool holder **86** that is engaged by a conventional machining device such as a turret **88** of a computer numeric control (CNC) machine. The holder **86** can define a base portion **87** that is structured to be received by the turret **88**. Further, a support portion **89** of the holder **86** can be structured to support the arm **82** at a predetermined angle relative to the rotatable

member **100**. For example, the support portion **89** can be angled relative to the base portion **87** by about 15° so that the tool **80** can be positioned proximate to the rotatable member **100** for forming, without the tool or arm otherwise contacting the fixture **10** or the rotatable member **100**. The machining device can adjust the position of the turret **88** and, hence, the holder **86**, arm **82**, and tool **80**, to select positions for forming the rotatable member **100**. Thus, as shown in Figure 1, the entire outside profile **112** of the radial portions **110** can be accessed by the tool **80**, without the tool **80** otherwise contacting the flanges **24** or other portions of the fixture **100**.

Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. For example, it is appreciated that each of the components of the present invention can be formed of any conventional structural materials including, for example, steels and other metals. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.